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Cost Analysis for a Decentralized Emissions Inspection/Maintenance Program for Massachusetts, Executive Summary

Booz-Allen and Hamilton, Inc, Bethesda, MD

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This report presents the results of an in-depth economic analysis of the costs of implementing a decentralized certified garage emisssions I/M program in Massachusetts. The analysis was performed on a life-cycle costs basis and considered the effects of inflation, growth in the vehicle fleet and labor rate escalation on the costs of the program.

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COST ANALYSIS FOR A DECENTRALIZED EMISSIONS INSPECTION/MAINTENANCE PROGRAM FOR MASSACHUSETTS

Executive Summary

PREFACE

Inspection/maintenance (I/M) is a term used to denote the periodic inspection of motor vehicles for emissions. The purpose of an I/M program is to identify vehicles which need remedial maintenance or adjustment to significantly reduce their emissions and to require repair of these vehicles. The reported benefits of an I/M program include reduced emissions, improved fuel economy, and improved vehicle performance. On the other hand, implementation of an I/M program has significant cost implications as well. These include the construction of buildings, the purchase of new equipment and the addition of new staff to handle increased program administration, data analysis, and program surveillance requirements.

With the passage of the Clean Air Act Amendments of 1977, the States are now required to achieve certain ambient air quality standards by December 31, 1982. While there are a number of ways to accomplish this, if a State cannot demonstrate attainment of the standards by that date, the State must include in its State Implementation Plan (SIP) revisions of January 1, 1979, a specific schedule for the implementation of I/M. To assist the Commonwealth of Massachusetts in selecting the most suitable alternative for achieving these standards, Booz, Allen & Hamilton was retained to perform an in-depth economic analysis of the costs of implementing a decentralized certified garage emissions I/M program in Massachusetts. The results of this analysis are presented in this report. A parallel study is being conducted by the Massachusetts Department of Environmental Quality Engineering on the State and contractor-operated I/M approaches.

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EXECUTIVE SUMMARY

This report summarizes the results of an in-depth economic analysis of the costs of implementing a decentralized, certified garage, motor vehicle emissions inspection/maintenance (I/M) program in the Commonwealth of Massachusetts. The objective of the analysis was to estimate the total program costs and the fee per vehicle to recover these costs. The results of the analysis are presented under the following headings:

- Description of the Emissions I/M Program Proposed for Massachusetts Utilizing Certified Garages
- Overview of the Methodology Employed in Estimating the Emissions I/M Program Costs and Fee
- The Calculation of Total Program Costs for the Proposed Certified Garage I/M Program on a Life Cycle Basis
- The Calculation of the Inspection Fee to be Self-Supporting for the Proposed Certified Garage I/M Program
- Potential Elements and Costs of a Combined Emissions I/M Program and a Modified Safety Inspection Program.

A description of the detailed methodology and data used in calculating the total program costs and fee are provided under separate cover.*

1. DESCRIPTION OF THE EMISSIONS I/M PROGRAM PROPOSED FOR MASSACHUSETTS UTILIZING CERTIFIED GARAGES

The assumed characteristics of the proposed certified garage motor vehicle emissions I/M program for Massachusetts were as follows:

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* U.S. Environmental Protection Agency, Cost Analysis for a Decentralized Emissions Inspection/Maintenance Program for Massachusetts: Technical Report, Prepared by Booz, Allen & Hamilton Inc., November 1978.

- Implementation of the emissions I/M program on a statewide basis in combination with the existing safety inspection program.

- Mandatory inspection of all light duty vehicles (LDV's)* less than 15 years old as of the start date of the program.

- Use of idle mode test to check vehicle emissions with an initial inspection failure rate of 20 percent.

- Annual inspection, evenly distributed over the year with a free reinspection for failed vehicles at the same station.+

- Use of a State-run quality audit and enforcement program (one State inspector for every 100 private inspection stations).

- Construction of a total of six state "referee" stations for the metropolitan areas of Boston (3), Springfield (1), Worcester (1), and Southeastern Massachusetts (1) for the purpose of handling consumer complaints about the program.

- Development and implementation of a four-week training program for State Inspectors and State mechanics involved in program administration and operation of the State referee stations.

- Addition of new State staff to handle the program administration, data analysis, and program surveillance requirements of the program.

- Purchase of exhaust emissions analyzers (and calibration gases) by the certified garages and by the State to carry out the emissions test.

- Purchase of computer equipment (four data entry devices) for the purpose of analyzing the collected vehicle emissions inspection test data.

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* For the purpose of this report, light-duty vehicles are defined as vehicles with a gross vehicle weight of 10,000 pounds or less.

\+ It is assumed that motor vehicle safety inspection frequency would be changed from six months to an annual basis so as to correspond with the emissions I/M program.

- Purchase and utilization of up to five mobile emissions inspection units operated by State Inspectors as auxiliary inspection stations, for example, in areas such as the Berkshires, Martha's Vineyard and Nantucket, or for spot-checking vehicles on the highway.*

The proposed program also assumed (for cost and analysis purposes) participation in the program of the 4,200 garages presently certified to perform safety inspections, as well as the following garage certification requirements:

- purchase of a State-approved emissions analyzer
- training/certification of at least one mechanic.+

2. OVERVIEW OF THE METHODOLOGY EMPLOYED IN ESTIMATING THE EMISSIONS I/M PROGRAM COSTS AND FEE

The methodology employed in determining the costs associated with the program outlined above and the inspection fee to be charged the motorist to recover these costs is shown in Figure 1. Calculation of the inspection fee was determined as follows:

- Comparing the elements of the existing safety inspection program with the requirements of a combined safety and emissions I/M program

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* Although it is presently illegal for Massachusetts police to stop a motor vehicle without probable cause of violation, a legislative change could be made to permit highway spot-checks in the future to aid in:

- Determining the effectiveness of the inspection and maintenance program in achieving lower emission levels in vehicles-in-use.
- Deterring vehicles from operating on public roads if they do not comply with applicable emissions standards.
- Assisting in the garage inspection and surveillance effort by conducting reinspections of vehicles which were recently inspected by a State-certified garage.

\+ These basic requirements might cause certain garages to drop out of the program. However, because of the uncertainty in determining the number of garages which will drop out, all cost analyses use 4,200 garages as a basis.

FIGURE 1
Overview of Methodology

- Determining the modifications required to superimpose an emissions test on the existing safety inspection program. (This included a changeover to annual inspection and the purchase of additional equipment and hiring of additional staff).
- Analyzing the costs associated with each program modification on a life cycle basis.*
- Determining the total number of vehicles which would be subject to inspection over the life of the program.

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* Life cycle costs are defined as the costs incurred by a program or system over its expected lifetime. Life cycle costs include costs due to inflation as well as wage and price escalation.

The inspection fee per vehicle was then determined by dividing the total program life-cycle costs by the total number of vehicles subject to inspection during the life of the program.

The analysis assumed that the program would begin on January 1, 1982 and would continue until at least December 31, 1986 (i.e., 5 years). This is consistent with the expected life (for cost purposes only) of existing I/M programs in other states. In addition, it was assumed that the program would be self-supporting. That is, it was assumed that all costs incurred by either the State or private garage in development, implementation or operation of the I/M program would be passed on to the consumer through the inspection fee.

In carrying out the analysis, costs were broken down into three categories--capital investment, start-up, and operating--and calculated based on:

- Data received from existing I/M programs in other States.
- Data gathered from discussions with local officials in Massachusetts.
- Conventional engineering cost-estimating procedures.

Wherever possible, site-specific data were used in the analysis (i.e., cost factors were obtained specifically for Massachusetts or the specific region or city involved). All costs were estimated in the following manner:

- Cost estimates were developed for each cost component (capital, start-up, and operating) in 1978 dollars
- The 1978 cost estimates were escalated to 1981 dollars (for capital and startup costs)* and to 1982 (for operating costs)* based on an annual inflation rate of five or ten percent.

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* This represents the first year that these costs are incurred.

3. THE CALCULATION OF PROGRAM COSTS FOR THE PROPOSED CERTIFIED GARAGE I/M PROGRAM ON A LIFE-CYCLE BASIS

As was described in the previous section, calculation of program costs for the proposed certified garage I/M program was based on life-cycle costing. That is, all costs associated with the development, implementation and operation of the proposed I/M program over the life of the program (assumed to be five years for costing purposes) were taken into consideration. This section presents the results of this analysis. The results are divided into the following sections in accordance with the methodology:

- Initial Capital Investment Costs
- Start-up Costs
- Annual Operating Costs
- Program Cost Summary.

Because of the uncertainty in the inflation rate over the next nine years (1978 - 1986), all cost figures are provided for two cases:

- Five percent annual inflation rate from 1978 - 1986
- Ten percent annual inflation rate from 1978 - 1986.

(1) Investment Costs

Investment costs are defined as the initial outlay of capital costs associated with a program. For the proposed I/M program, these costs will be incurred in 1981 and will include:

- The construction of State challenge garages (building and land costs) for the purpose of handling consumer complaints about the program
- The purchase of exhaust emissions analyzers (for both the State and private garages) to carry out the emissions test.
- The purchase of mobile vans by the State for use as auxiliary inspection stations and for spot-checking vehicles on the highway

- The purchase of computer equipment by the State for analyzing the collected vehicle emissions inspection test data.

A summary of these costs for alternative inflation rates of five and ten percent is shown in Table 1.

The initial investment costs shown in the table were based on the following data:

- Land cost data obtained from discussions with real estate brokers in Massachusetts.
- Building costs data estimated using conventional engineering cost estimating procedures.
- Equipment cost data obtained from the major equipment manufacturers.

All costs were originally estimated in 1978 dollars and escalated to 1981 dollars based on the alternative estimates of the annual inflation rate between 1978 and 1981.

The life-cycle costs shown in the table for each capital investment were determined by:

- Multiplying the unit cost per item by the number of items required to arrive at a total initial cost for each capital investment (1981 dollars)
- Amortizing each initial capital investment cost over the life of the I/M program (for costing purposes, assumed to be five years).

The interest rate used in amortizing the costs was ten percent for the State and 12 percent for the private garage.

To arrive at the TOTAL capital investment life-cycle cost shown in the table, the following procedure was employed:

- The life-cycle costs computed for each capital investment item were summed.
- The remaining (salvage) value of the buildings and land at the end of five years were subtracted from the summation.

TABLE 1
Summary of Initial and Life Cycle Investment Costs for Annual Inflation Rates of Five and Ten Percent

ITEM	Unit Cost Per Item (1978 Dollars)		Number Required	Total Initial Cost (1978 Dollars)		Life Cycle Cost** (1982 - 1986)	
	5 Percent	10 Percent		5 Percent	10 Percent	5 Percent	10 Percent
Challenge Garage							
Building	$108,000	$124,000	6	$648,000	$744,000	$855,000	$982,000
Land	21,000	24,000	6	126,000	144,000	166,000	190,000
Emissions Analyzers							
State	2,550	2,930	29	74,000	85,000	98,000	112,000
Private Garage	2,550	2,930	4,200	10,710,000	12,306,000	14,887,000	17,105,000
Computer Equipment	1,740	1,995	4	7,000	8,000	9,000	11,000
Mobile Units*	12,000	13,760	5	60,000	69,000	83,000	91,000
Subtotal						$16,098,000	$18,491,000
Salary Value Credit						(730,000)	(730,000)
TOTAL	-	-	-	$11,625,000	$13,356,000	$15,368,000	$17,761,000

* Includes hand held tools needed for safety inspection plus one generator per van

** Initial capital investment costs amortized over 5 years at a rate of 10 percent per year for State and 12 percent per year for private garages.

(2) Start-Up Costs

Start-up costs are defined as those costs other than capital costs which are incurred before the program is operational. These costs will also be incurred in 1981 for the proposed I/M program and will include the following:

- Initial State Labor Charges--Cost for a small group of State employees to lay the foundation for the program during the year prior to start-up.
- Program Design Costs--Technical support to the State for actual design of the program.
- Public Information Costs--Costs of the initial stages of a public information program, i.e., media campaign to inform the public about the program, seminars for repair establishment management, and a consumer affairs office.*
- Inspector/Mechanic Training Costs--Cost associated with organization of the training program, of supplies (i.e., books) and the initial training of inspectors/mechanics and the State enforcement staff.

Estimates of these start-up costs based on extrapolations of information obtained from contacts with existing I/M programs in Arizona and Rhode Island are presented in Table 2.

As in the analysis of capital investment costs, the "initial" start-up costs shown in the table were estimated in 1978 dollars and escalated to 1981 dollars based on an estimate of the annual inflation rate over the 1978-1981 time frame. Similarly, life-cycle start-up costs were determined by amortizing the initial costs over the life of the program. This was done at the rate of ten percent per year for the State and 12 percent per year for the private garages.

* Because of the importance of a public information program, these costs are incurred prior to program start-up and also prior to the requirement for mandatory repair (one year after start-up).

TABLE 2
Summary of Initial and Life-Cycle Start-Up Costs
For Annual Inflation Rates of Five and Ten Percent

Start-Up Cost Component	Initial Cost (1981 Dollars)		Life-Cycle Cost** (1982 - 1986)	
	5 Percent	10 Percent	5 Percent	10 Percent
Labor	$ 198,000	$ 227,000	$ 261,000	$ 300,000
Program Design	116,000	133,000	153,000	176,000
Public Information*	1,346,000	1,543,000	1,777,000	2,037,000
Training				
State	51,000	58,000	67,000	77,000
Private Garage	768,000	881,000	1,068,000	1,163,000
TOTAL	$2,479,000	2,842,000	3,326,000	3,753,000

* Costs incurred prior to program start-up and one year later.

** Start-up costs amortized over five years at rate of ten percent per year for State and 12 per year for private garages.

(3) Operating Costs

Operating costs are those which will be associated with the day-to-day operation of the program over the time frame 1982 - 1986. These costs include the following:

- Program administration costs for the salaries of personnel involved in continuing program enforcement, consumer protection, program evaluation, mechanic/inspector training, clerical support, garage licensing, data processing, program surveillance, and program management.

- Public information costs required on a continuing basis to keep the public informed about the program.

- Emissions testing costs, i.e., salary and overhead costs, borne by the private garages in performing the inspections.

- Utilities and supplies costs for the purchase of office supplies, computer charges and the operation of State challenge garages (fuel oil and electricity) and mobile vans (gasoline and oil).

- Maintenance and repair costs for the upkeep of the challenge garages, private garage emissions analyzers, computer equipment and mobile vans.

Estimates of these costs for both the State and private garages are shown in Table 3. The estimating methods for these costs are described below.

- State Labor Costs. These were based on a total staff of 67 people and their projected salaries. The staff estimate was based on analysis of the staff levels of similar I/M programs in Nevada and Rhode Island. The projected salary estimates were based on existing State employee wages escalated to 1982 at an annual rate of five or ten percent.

- Private Garage Labor Costs. These were based on the time required to conduct the emissions test (five minutes) and the hourly service rate of the average garage. The hourly service rate was assumed to be $15.00 (1978 costs), based on a survey of independent garages and dealers in the Boston, Springfield and Worcester areas.

- Public Information Costs. These were based on the operating budgets of I/M programs in other States. These costs were estimated at a rate of approximately ten cents per vehicle inspected per year (1978 costs) inflated appropriately over the 1982 - 1986 time frame.

- Utilities, Supplies, Maintenance, and Repair Costs. These were based on data received from

equipment manufacturers, existing I/M programs in other States, the Massachusetts Registry of Motor Vehicles, and conventional engineering cost estimating procedures.

TABLE 3
Summary of First Year and Life Cycle Operating Costs for Annual Inflation Rates of Five and Ten Percent

Operating Cost Component	First Year Operating Costs (1982 Dollars)		Life Cycle Cost (1982 - 1986)	
	5 percent	10 percent	5 percent	10 percent
Labor				
State	$ 1,877,000	$ 2,265,000	$10,360,000	$13,817,000
Private Garage	7,572,000	9,162,000	46,062,000	61,531,000
Public Information	556,000	671,000	3,070,000	4,094,000
Utilities and Supplies	70,000	84,000	386,000	512,000
Maintenance and Repair				
State	13,000	16,000	72,000	98,000
Private Garage	269,000	324,000	1,486,000	1,976,000
TOTAL	$10,357,000	$12,522,000	$61,436,000	$82,028,000

As in the analyses of capital investment and start-up costs, all costs were originally estimated in 1978 dollars and escalated to 1982 dollars based on an estimate of the annual inflation rate over the 1978 - 1982 time frame.

The life-cycle operating costs shown in the table were determined by summing the first year annual operating costs adjusted for inflation over the life of the program.

(4) Summary of Program Life-Cycle Costs

The cost analysis results described in the previous sections are summarized in Table 4. As shown in the table, the private garages bear the major economic burden. The analysis indicates that the average garage would have an initial capital investment ranging between $2,550 and $2,930 and a start-up cost ranging between $182 and $210 (primarily for training). The average annual operating cost per garage would range between $2,264 and $3,024.

TABLE 4
Summary of Capital Investment, Start-up and Operating Costs for Both State and Private Garages for Inflation Rates of Five and Ten Percent

COST ELEMENT	STATE		PRIVATE GARAGES (Total)		PRIVATE GARAGES (Individually)	
	5%	10%	5%	10%	5%	10%
CAPITAL INVESTMENT						
Initial Costs (1981 Dollars)	$ 915,000	$1,050,000	$10,710,000	$12,306,000	$ 2,550	$ 2,930
Life Cycle Costs (1982-1986)	481,000*	656,000*	14,887,000	17,105,000	3,545	4,073
START-UP						
Initial Costs (1981 Dollars)	1,711,000	1,961,000	768,000	881,000	182	210
Life Cycle Costs (1982-1986)	2,258,000	2,590,000	1,068,000	1,163,000	254	277
OPERATING						
Average Annual Costs (1982-1986)	2,778,000	3,704,000	9,510,000	12,701,000	2,264	3,024
Life Cycle Costs (1982-1986)	13,888,000	18,521,000	47,548,000	63,507,000	11,321	15,121
TOTAL PROGRAM						
Initial Costs (1981 Dollars)	2,626,000	3,011,000	11,478,000	13,187,000	2,732	3,140
Life Cycle Costs (1982-1986)	16,627,000	21,767,000	63,503,000	81,775,000	15,120	19,471

* Includes salvage value credit of $730,000.

As also shown in the table, capital investment and start-up costs for the I/M program taken together exceed average annual operating costs. This results in a high initial program expenditure rate as shown in Figure 2.

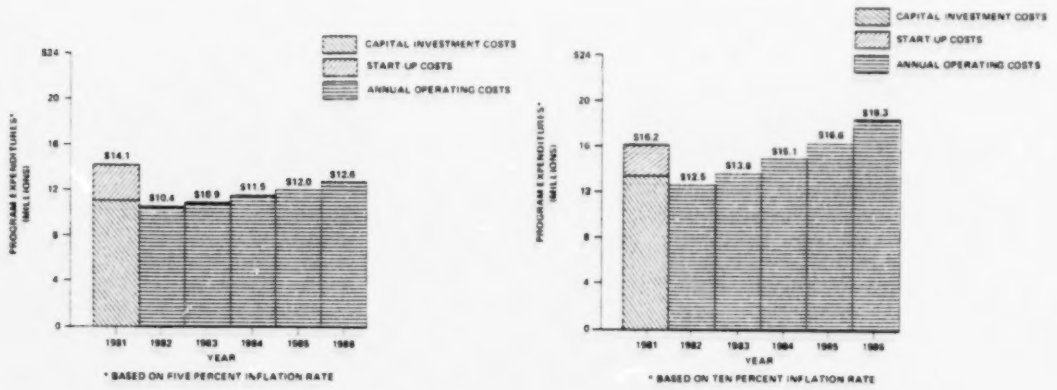

FIGURE 2
Comparison of Program Expenditures Over the Life-Cycle

When funds to cover this initially high investment are borrowed (at 10 percent for Massachusetts and at 12 percent for private garages) then actual program costs are as shown in Figure 3.

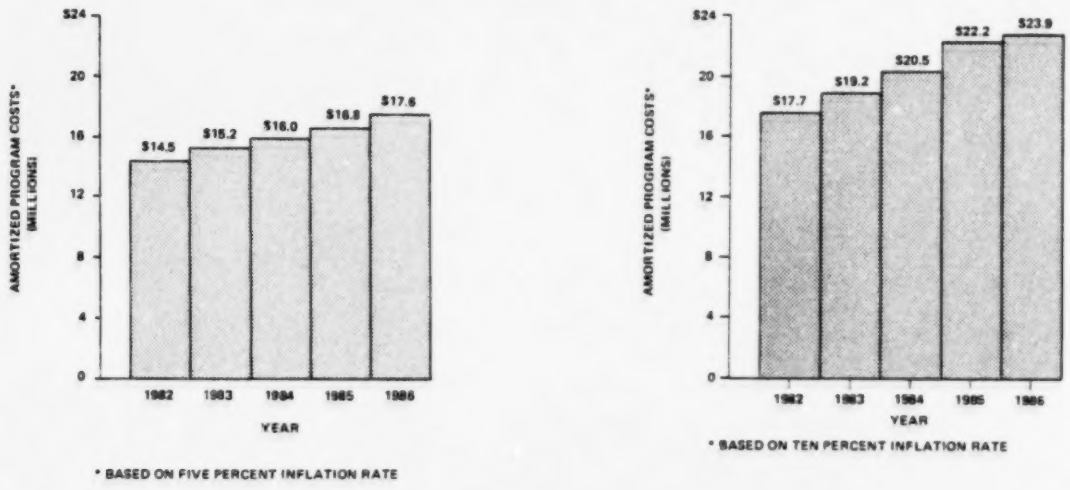

FIGURE 3
Comparison of Actual Program Costs Over the Life Cycle

4. CALCULATION OF THE INSPECTION FEE TO BE SELF-SUPPORTING FOR THE PROPOSED CERTIFIED GARAGE I/M PROGRAM

The final step in the analysis as shown in Figure 1 was to determine the fee charge required to make the emissions I/M portion of the overall vehicle inspection program self-supporting. This was accomplished as described previously by dividing the total I/M program life-cycle costs (State plus private garage) by the total number of vehicles estimated to be inspected over the life of the program. An estimate of the number of vehicles to be inspected over the life of the program (1982 - 1986) is shown in Table 5 (i.e., 22,900,000).

TABLE 5
Projected Number of Light Duty Vehicles
Less Than 15 Years Old by Vehicle Class
Over Life-Cycle (1982-1986)

Vehicle Class	Vehicle Registrations (1982)	Life-Cycle Vehicle Registrations (1982-1986)
Passenger Vehicle	3,742,000	20,500,000
Motorcycles	103,000	600,000
Commercial Vehicles	289,000	1,600,000
State and Municipal Vehicle	38,000	200,000
TOTAL	4,172,000	22,900,000

The estimates shown in Table 5 were based on the following:

- Vehicle registration data obtained from the Massachusetts Registry of Motor Vehicles for 1978
- Data obtained from the U.S. Bureau of Census on the distribution of truck weights in the United States
- Data obtained from the Motor Vehicle Manufacturers Association on the distribution of vehicles by age

- Linear extrapolation of the 1978 vehicle registration data adjusted for age and weight from 1978 to 1982 and from 1982 to 1986 at an annual rate of 4.3 percent.*

Using the data presented previously in Table 4 and that presented in Table 5, the fee charge required to make the emissions I/M portion of the overall vehicle inspection program self-supporting was then calculated as follows:

$$\text{Fee Charge Required to Make Program Self-Supporting} = \frac{\text{Total Program Life-Cycle Costs}}{\text{Life-Cycle Vehicle Registrations}}$$

A summary of this fee calculation is presented in Table 6.

As shown, the fee required to make the emissions I/M portion of the overall vehicle inspection program self-supporting ranges between $3.50 and $4.52 depending on the inflation rate. Also, as shown, the bulk of the fee (79 percent) goes to cover the costs of private garages. These costs are primarily labor costs. For this reason, the required fee would probably have to be increased in 1987 because of increased mechanic labor rates if the program continued. Figure 4 displays the rate at which the required break-even fee for the emissions I/M program increases over the five-year program period.

5. POTENTIAL ELEMENTS AND COSTS OF A COMBINED EMISSIONS I/M PROGRAM AND A MODIFIED SAFETY INSPECTION PROGRAM

Given the well-established periodic safety inspection program in Massachusetts, a logical way to meet the requirements for a transportation pollution control program is to superimpose an emissions test onto the existing safety inspection. Up to this point, only the results of an emissions I/M program cost analysis have been discussed. This section discusses the results of the following additional analyses:

- Estimation of fee for combined annual emissions and existing safety inspection program

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* The 4.3 percent annual growth rate factor was based on analysis of vehicle registration data received from the Registry of Motor Vehicles for the ten year period 1969 - 1978.

TABLE 6
Summary of Fee Calculation

	Total Program Life Cycle Costs		Life Cycle Vehicle Registration	Average Annual Inspection Fee		Percent of Total Fee	
	5 Percent	10 Percent		5 Percent	10 Percent	5 Percent	10 Percent
State	$16,627,000	$21,767,000	22,900,000	$0.73	$0.95	21%	21%
Private Garage	63,503,000	81,775,000	22,900,000	2.77	3.57	79%	79%
Total	$80,130,000	$103,542,000	22,900,000	$3.50	$4.52	100%	100%

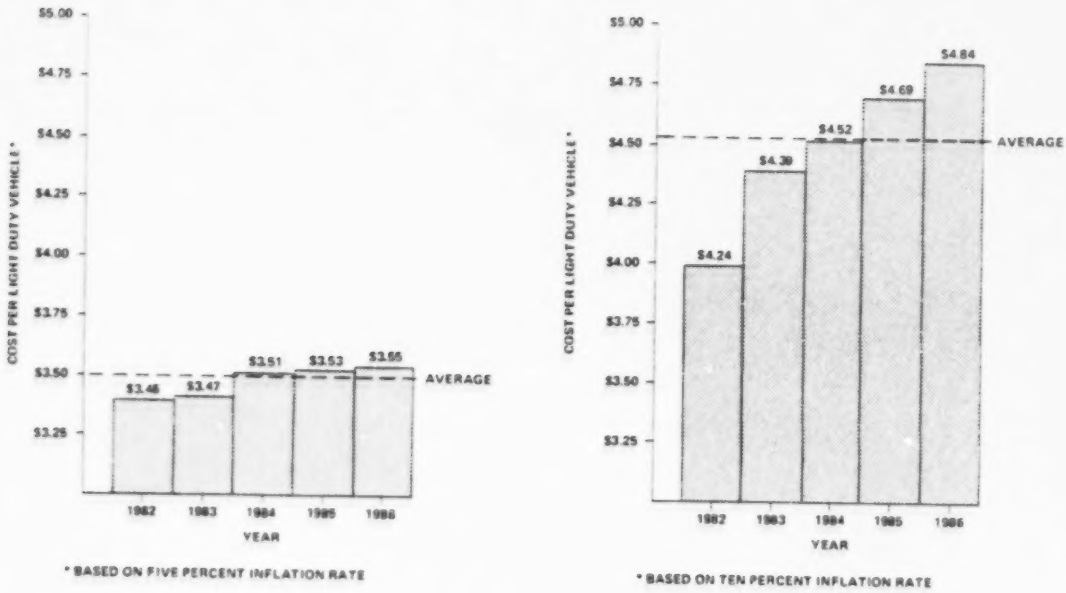

FIGURE 4
Comparison of Inspection Cost
Per LDV Over the Life-Cycle

- Estimation of fee for combined emissions inspection with an annual safety inspection upgraded to fully comply with Federal Vehicle-In-Use (VIU) inspection guidelines.

(1) Combined Annual Emissions and Existing Safety Inspection Program

The present safety inspection fee in Massachusetts is $2.00. The same fee has been in existence since 1930 and is collected twice a year from motorists having their vehicles inspected. The entire fee is retained by the private garage and as such, the program is not self-supporting.

The program has an annual budget of $950,000, and employs a staff of approximately 57, including 50 inspectors, a program director, and six persons in clerical and secretarial positions. All expenses incurred in the program are paid for from the State general fund,

including the printing and distribution of stickers, forms, and other materials to the approximately 4,200 certified garages.

To determine the combined annual emissions/safety inspection fee, the existing safety inspection program had to be made self-supporting. Additionally, since the $2.00 safety inspection fee established back in 1930 is obviously outdated, the fee also had to reflect projected garage service rates over the 1982-1986 timeframe. To accomplish this, the following analyses were conducted:

- The existing annual safety inspection budget of $950,000 was inflated to 1982 dollars and the life-cycle operating costs over the 1982 - 1986 time period calculated.

- The life-cycle costs which would be incurred by the private garages in conducting safety inspections on all eligible vehicles over the time frame 1982 - 1986 were calculated. This was accomplished assuming a ten minute safety inspection and a $15.00 per hour (1978 costs) average garage service rate inflated over the 1982 - 1986 time period.

- The above costs were divided by the anticipated number of vehicles to be inspected (from Table 5) over the five-year life of the program (i.e., 22,900,000) to determine the average annual safety inspection cost per vehicle. This figure was added to the computed emissions inspection cost per vehicle for the same time period to arrive at a combined annual emissions/safety inspection program cost per vehicle.

The results of this analysis are presented in Table 7.

(2) Combined Annual Emissions and Safety Inspection Program Upgraded to NHTSA VIU Guidelines

A comparison of the NHTSA VIU and Massachusetts inspection standards is presented in Table 8. As shown in the table, NHTSA VIU standards prescribe tests only for those systems which have been shown to

TABLE 7
Inspection Cost Per Vehicle of a Combined
Annual Emissions and Existing Safety Inspection Program

Cost Element	Life-Cycle Costs (1982-1986)		Life-Cycle Vehicle Registrations (1982-1986)	Average Annual Safety Inspection Cost Per Vehicle		Average Annual Emission Inspection Cost Per Vehicle		Average Combined Safety/Emissions Cost Per Vehicle	
	5 Percent	10 Percent		5 Percent	10 Percent	5 Percent	10 Percent	5 Percent	10 Percent
State Safety Inspection Operating Cost	$6,345,000	$8,461,000	22,900,000	$0.28	$0.37	$0.73	$0.95	$1.01	$1.32
Private Garage Safety Inspection Labor Cost	92,124,000	123,062,000	22,900,000	4.02	5.37	2.77	3.57	6.79	8.94
TOTAL	$98,469,000	$131,523,000	22,900,000	$4.30	$5.74	$3.50	$4.52	$7.80	$10.26

TABLE 8
Comparison of NHTSA and Massachusetts
Vehicle System/Component Inspection Requirements

Vehicle System/Component	NHTSA	Massachusetts
Service Brake System	X	X
Failure Indicator	X	
Brake System Integrity	X	X
Brake Pedal Reserve	X	
Service Brake Performance	X	X
Brake Hoses and Assemblies	X	
Disc and Drum Condition	X	
Friction Materials	X	
Structural and Mechanical Parts	X	
Parking Brake		X
Brake Power Unit	X	
Steering	X	X
System Play	X	X
Linkage Play	X	X
Free Turning	X	X
Alignment	X	
Power Steering System	X	
Suspension	X	
Suspension Condition	X	
Shock Absorber Condition	X	
Tires	X	X
Tread Depth	X	X
Tread Type	X	
General Condition	X	X
Damage	X	X
Wheel Assembly	X	
Wheel Integrity	X	
Deformation	X	
Mounting	X	
Lights		X
Headlamp Aim		X
Rear Lamps		X
Marker Lights		X
Exhaust System		X
Horn		X
Glazing		X
Windshield		X
Rear Windows		X
Bumpers, Fenders and Body		X

be major causal or contributing factors to accidents, i.e., brakes, steering, alignment, suspension, tires and wheel assembly. In contrast, Massachusetts standards prescribe inspection of three of the systems recommended by NHTSA (brakes, steering and tires) plus five others which are safety-related, but not included in the NHTSA standards (headlights, muffler and exhaust, horn, glazing and body). Massachusetts inspection regulations do not presently require:

- Visual inspection of:
  - Brake failure indicators
  - Brake pedal reserve
  - Brake hoses and assemblies
  - Brake power unit
  - Power steering system
  - Suspension and shock absorber condition
  - Tread type
  - Wheel mounting and integrity.
- Mechanical inspection of wheel alignment using a bar-type, scuff gauge or other toe-in measuring device.
- The removal of one front wheel and one rear wheel to inspect disc and drum condition, friction materials, structural and mechanical parts.

Thus, to upgrade Massachusetts safety inspection to the NHTSA VIU guidelines, the above inspection tests would have to be added to the safety inspection program. To estimate the impact these additional tests would have on the inspection cost per vehicle, the following analyses were conducted:

- The fees and inspection procedures of 13 states in the New England and Mid Atlantic regions were analyzed.
- Estimates of the time required to perform the additional tests were made based on data contained in Chilton's and Glenn's automotive flat rate manuals, the Motor Vehicle Manufacturers Association (MVMA) inspection manual, NHTSA reports on vehicle testing, and inspection test times data received from other States.

Of the 13 States surveyed, only four (New York, Rhode Island, Virginia and West Virginia) were found to have periodic inspection programs broadly similar to the type of program contemplated for Massachusetts. All four require a wheel pull as part of the brake test, are operated by certified garages and have a standardized inspection fee. Only Rhode Island, however, has an annual emissions inspection test. A summary of the fees for these four programs is shown in Table 9.

TABLE 9
Summary of Inspection Fees For
Inspection Programs Similar to Massachusetts

State	Inspection Fee
New York	$3.00
Rhode Island	$4.00
Virginia	$4.00
West Virginia	$4.62*

The average of the four fees is $3.90, and the most frequent fee is $4.00. However, because these fees do not contain all the inspection requirements contemplated by Massachusetts, it was determined that it would be inappropriate to extrapolate these fees to the Massachusetts situation. Thus, to determine the cost per vehicle of upgrading the Massachusetts safety inspection program to NHTSA VIU guidelines, the life-cycle costs which would be incurred by the private garages in conducting such an inspection were calculated. The results of this analysis are shown in Table 10.

* In West Virginia, a 3 percent tax is levied on the garage inspection fee of $4.00. In addition, the motorist pays a $0.50 surcharge to the State. $4.00 + $0.12 + $0.50 = $4.62.

TABLE 10
Inspection Cost Per Vehicle of a Combined Annual Emissions and Upgraded Safety Inspection Program

	Five Percent Inflation	Ten Percent Inflation
Life-Cycle Cost of NHTSA VIU Modifications	$156,612,000	$204,206,000
Life-Cycle Vehicle Registrations	22,900,000	22,900,000
Cost Per Vehicle of NHTSA VIU Modifications	$ 6.84	$ 9.13
Cost Per Vehicle of Existing Safety Inspection	4.30	5.74
Cost Per Vehicle of Annual Emission Inspection	3.50	4.52
Combined Annual Emissions/Upgraded Safety Inspection Program	$ 14.64	$ 19.39

(3) Comparison of Annual Inspection Costs per Motor Vehicle for Self-Sustaining Emissions and Safety I/M Programs

Table 11 presents the results of life-cycle cost calculations for three I/M programs for Massachusetts as follows:

- Emissions I/M Program Only: Table 11 displays self-sustaining program costs of emissions I/M, if it were totally separated from safety inspection. Costs per vehicle inspected are shown in the 1982 - 1986 time frame for two inflation rate assumptions (five percent and ten percent).

TABLE 11

A Comparison of the Worst Case Annual Inspection Cost Per Motor Vehicle for Self-Sustaining Emissions And/Or Safety Inspection and Maintenance Programs (1982-1986 Time Frame For Two Inflation Rates)

PROGRAM DESCRIPTION	REQUIRED FEE/VEHICLE/YEAR (Self-Sustaining)	
	5% Inflation	10% Inflation
1. Emissions I/M Program Only	$3.50	$4.52
2. Emissions I/M and Safety Inspection to Current Standards (Annual	$7.80	$10.26
3. Emissions I/M and Upgraded Safety Inspection Standards (Annual)	$14.64	$19.39

. Emissions I/M and Annual Safety Inspection to Current Standards: This self-sustaining program combines emissions and safety inspection as a single annual inspection. The numbers shown in Table 11 represent a worst case in which:

- All costs, both public and private, are accounted for in the fee
- A ten-minute safety inspection to current standards is assumed and all garage costs are covered by the fee*
- No administrative economies are assumed in in the public sector in the combined program administration

* The current fee of $2.00 per safety inspection was established at a time when garage labor rates were considerably lower than they are at present. For garages to be self-sustaining with the current fee, inspections must be performed in five minutes or less.

- Emissions I/M and Upgraded Annual Safety Inspection Standards: This is also a self-sustaining program. Again the results of detailed calculations shown in Table 11 represent a worst case. The assumptions are the same as those listed above with one addition. Upgrading current Massachusetts inspection standards to the level of those recommended by the U.S. Department of Transportation, National Highway Traffic Safety Administration is assumed (see Table 8). This increases garage inspection time from about ten minutes to 27 minutes. The additional inspection tasks, which together require the additional 17 minutes, include wheel pulling to check brakes, front end alignment and additional visual inspection items. This additional inspection time is based on worst case assumptions.

Because of the worst case assumptions included in the detailed calculations and the projected inflation rates the projected self-sustaining inspection fees are very high compared to those of current programs. This is to be expected!! These are worst case fees and are inappropriate for consideration except as an interim step in the calculation.

In reality, existing I/M program combined emissions and safety inspections take advantage of two key economies as follows:

- Public sector costs are reduced by combining joint administrative functions related to both safety and emissions inspections

- Private sector inspection charges are less than those which are calculated on a strict time and standard labor charge basis.

Overall costs as reflected in the required fee for a self-sustaining program can be reduced only a few percent by economies in the public sector. On the other hand, private sector charges must include appropriate reductions possible as a result of opportunities for other garage business generated by the inspection process. As a worst case, Table 11 assumes for cost analysis purposes a situation where an individual garage is not permitted to perform any repairs

on automobiles it inspects. Table 11 results also assume that a garage serving as an inspection station cannot perform any repairs on any automotive components that failed inspection at another inspection station. Such assumptions are inherent in any calculation which assumes that each inspection must pay for itself totally.

Table 12 presents the final results of the analysis of required fee if public sector economies and current private sector business practices relative to inspection in Massachusetts* are taken into account.

TABLE 12

A Comparison of the Expected Annual Inspection Cost Per Motor Vehicle for Self-Sustaining Emissions And/Or Safety Inspection And Maintenance Programs (1982-1986 Time Frame, For Two Inflation Rates)

Program Description	Required Fee/Vehicle/Year	
	5% Inflation	10% Inflation
1. Emissions I/M Program Only	$2.00 to $2.75	$2.60 to $3.60
2. Emissions I/M and Safety Inspection to Current Standards (Annual)	$4.35 to $6.10	$5.74 to $8.00
3. Emissions I/M and Upgraded Safety Inspection Standards (Annual)	$7.76 to $11.13	$10.28 to $14.74

* Fee estimates in Table 12 related to private sector costs assume that garages continue to recover the same percentage of their costs for each inspection as they do today at the lower number, but capture 25% more of their costs than currently permitted at the upper number.

Because the final combined program for emissions and safety I/M is not precisely defined, the required fee must be presented as a range. The fees shown in Table 12, however, are based upon the fact that private garages will be permitted to repair items which fail inspections. A comparison of Tables 11 and 12 indicates that this is a very important aspect of the program if costs to the consumer are to be acceptable. Program costs as reflected in the fees shown in Table 12 include adequate public sector surveillance, facility inspection, and challenge garage provisions to assure consumers that they are receiving appropriate inspection results. Table 12 also clearly displays the impact that inflation rate can have on the required fee for a self-sustaining system. Analysis indicates that inflation rate is the single most important unknown that can cause the greatest change in required inspection fee. For that reason, both Tables 11 and 12 results are presented for two different inflation rates.

GLOSSARY

AMBIENT AIR: The surrounding or outside air.

CALIBRATION GASES: A blend of HC and CO gases using nitrogen as a carrier gas.

CAPITAL INVESTMENT: Initial expenditures for goods necessary for the operation of a program (e.g., building, land and equipment).

CERTIFIED MECHANIC: An individual licensed by the State to inspect motor vehicle engine emissions related components and pollution control devices for compliance with specified emissions standards.

CERTIFIED STATION: A private facility licensed by the State to inspect motor vehicle engine emissions related components and pollution control devices for compliance with specified emissions standards.

EMISSION INSPECTION/MAINTENANCE PROGRAM: An inspection and maintenance program in which each vehicle is subjected at specified intervals to a test of its emissions under specified conditions. The emission levels are compared with a standard established for the vehicle class. If the emissions are higher than the standards, the vehicle is failed and must be adjusted or repaired to bring its emissions into compliance with the standards.

EXHAUST GAS ANALYZER: An instrument for sensing the amount of air contaminants in the exhaust emissions of a motor vehicle.

EXHAUST EMISSIONS: The products of combustion emitted into the ambient air from any opening downstream of the exhaust ports of a motor vehicle engine.

HEAVY-DUTY VEHICLE: Any motor vehicle designed for highway use which has a gross vehicle weight of more than 10,000 pounds.

IDLE TEST: An emission inspection program which measures the exhaust emission from a motor vehicle operating at idle. (No motion of the rear wheels.) A vehicle with an

automatic transmission may be in drive gear with brakes applied or in neutral gear.

INSPECTION FEE: Annual payment for inspecting a vehicle.

INSPECTOR: An individual who inspects motor vehicles and pollution control devices for compliance with applicable regulations.

LIFE CYCLE COSTS: Total of all costs incurred by a program during a predetermined period (life cycle).

LIGHT-DUTY VEHICLE: A motor vehicle designed for highway use of less than 10,001 pounds gross vehicle weight. Further distinctions are sometimes made between light-duty automobiles and light-duty trucks such as pickup trucks.

MODEL YEAR OF ENGINE: The production period of new vehicle or new vehicle engines designated by the calendar year in which such period ends.

OPERATING COSTS: Annual costs incurred during the operation of a program.

START-UP COSTS: Initial expenditures for services necessary for laying the foundation of a program (e.g., initial labor costs, initial training, initial public information and program design).

VEHICLE EMISSIONS STANDARD: A specific emission limit allowed for the class of vehicles. The standard is normally expressed in terms of maximum allowable concentrations of pollutants (e.g., parts per million). However, a standard could also be expressed in terms of mass emissions per unit of time or distance traveled (e.g., grams per mile).